the currents of the water, caused by waves, wind, or tides, and doubtless in many cases through the incessant movements of some marine animals. The greater the distance between the antheridia and the carpogonia, the smaller are, of course, the chances of fertilisation; the more violently the water is moved about in the vicinity of and between the separated organs, the more probably will the lucky accident of the union of both elements take place.

During a long series of investigations of the reproductive phenomena of Polysiphonia, Dr. Dodel-Port found regularly on the bushy thallus, and particularly upon the uppermost and youngest branches, an enormous number of the well-known stalked animalcules, Vorticellæ, which had settled there, and were, as usual, in incessant motion. Often they appeared in dozens in the field of the microscope, and, with the constant vibration of their cilia, they were very troublesome, at least up to the moment when Dr. Dodel-Port had directly observed their friendly co-operation in the fertilisation he was studying. He was a frequent witness of the process depicted in Fig. 3, where numerous antherozoids were whirled round and round in the whirl caused by a Vorticella, and where frequently antherozoids came into contact with the trichogyne, and remained attached to it (Fig. 3, s' and s'') for a longer or shorter period. It was entirely due to the motion caused by Vorticellæ that Dr. Dodel-Port was enabled to follow the phenomenon of the attachment of the antherozoids to the trichogyne from beginning to end. The motions of the Vorticellæ are particularly varied through the repeated contractions of their stalks into short spirals, and thus they cause various currents in the water, by all of which the antherozoids are carried along like any other small passive body that may be suspended in the water. (Compare Fig. 2, where one of the Vorticellæ is just contracting its stalk, the arrows in each case indicating the direction of the currents.)

The presence of numerous Vorticellæ thus imparts to the passive antherozoids a kind of motion much resembling that of the sperm-cells of other cryptogams which are endowed with active cilia. From this follows, with mathematical certainty, that the probability of the antherozoid falling on the trichogyne in the presence of Vorticellæ is immensely greater than that which would exist were there no animals present.

At the same time, it is evident that this probability is yet increased in the case of *Polysiphonia subulata* through the presence of the forked hair, *g h*, in the vicinity of the trichogyne, because the whirls caused by the animalcules will often be cleft by the forked hair, and thus secondary whirls will be produced. Often in Polysiphonia, carpogonia were found which were not fertilised. Thus Fig. 4 represents a ripe and spore-ejecting cystocarp, *c y*, and two carpogonia, *u c g*, which remained unfertilised. This was particularly the case on thallus-branches, which were less densely crowded with Vorticellæ—another, although negative, proof of Dr. Dodel-Port's theory. It is not particularly remarkable that Vorticella should inhabit Polysiphonia in large numbers, because these animalcules, as Dr. Dodel-Port observed, feed with predilection on the antherozoids of this plant. Thus we have here a condition of things similar to the relations between certain flowers and pollen-consuming insects. The consumption of antherozoids by the Vorticellæ is, of course, far too insignificant to merit any consideration, particularly if compared to the great advantages regarding fertilisation which the presence of the animalcules brings with it. Moreover, a comparison of the male plant of Polysiphonia with a female specimen shows that here also, as in most phanerogams, thousands more male cells are formed than are necessary for fertilisation.

After fertilisation the carpogonium develops into a cystocarp, *i.e.*, the spore-forming fruit (Fig. 4). Shortly after fertilisation the whole hair apparatus disappears. The wall-cells of the carpogonium now begin to grow quickly and to divide by membranes perpendicular to the surface. They form a cellular case (*h h*, Fig. 4), which has an orifice in the apex, long before the spores are ripe. In the meantime the central cell of the fertilised carpogonium begins to form a number of densely-packed short branches, which, as a series of cells radiating in all directions, fill the basis of the capsule-shaped fruit. The central cell is therefore called the placenta-cell. At the ends of the ramified cell-series which radiate from it, pear-shaped and dark red spores form (carpospores), which, as soon as they have attained a certain size, become detached and pass into the water through the orifice at the apex of the cystocarp. In this state they are perfectly capable of further development and soon begin to germinate.

Dr. Dodel-Port concludes his interesting treatise with the following suggestive sentences:—

"The total absence of active organs of locomotion in the antherozoids of Florideæ points to a common ancestor from which the different branches of the Florideæ have inherited the immobility of the antherozoids. No doubt that during the differentiation of the red seaweeds many forms have died out in consequence of the fertilisation not taking place through the passivity of the male cells, while other forms have retired to localities which through active water-currents favour the process of fertilisation in spite of the immobility of the antherozoids. It is well known that now we find most of the present species of Florideæ on the coasts of warmer seas, which are constantly washed by the waves, while the northern coasts, which are covered by crusts of ice during a great portion of the year, are very poor in red seaweeds. Future researches will have to show how far in many of these aquatic plants the differentiation of the genera took place in the sense of an adaptation to the small marine animals which inhabit them and favour their fertilisation in the way I have pointed out. If many seaweeds in their bushy shrub-like thallus harbour certain infusoria, bryozoa, hydræ, sponges, crustacea, annelids, and small starfishes, and offer to them excellent hiding-places or nourishment, so that these animals inhabit them with special predilection, then it is certainly possible that occasionally a correlation was formed or adaptation took place, which was mutually advantageous and which would find numerous analogies in the domain of the multiple cross relations between the higher flowering plants and insects. In this sense I consider it my duty to submit to the criticism of biologists a point hitherto overlooked in the biology of red seaweeds, and bearing upon the explanation of the morphological differentiation of submerged aquatic plants."

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee appointed for the Purpose of Arranging for the Occupation of a Table at the Zoological Station at Naples, the Committee consisting of Dr. M. Foster, Prof. Rolleston, Mr. Dew-Smith (Secretary), Prof. Huxley, Dr. Carpenter, Dr. Gwyn Jeffreys, Mr. Sclater, Mr. F. M. Balfour, Sir C. Wyville Thomson, and Prof. Ray Lankester.—Since we submitted our last Report to the Association, the Zoological Station at Naples has continued to be successful in providing opportunity and appliances for naturalists studying the various forms of marine animals and plants. From September 1, 1878, to the end of July, 1879, twenty-six naturalists have occupied the tables at the Institution. A list of their names and the time of stay will be found appended. During the same period, packages of specimens have been forwarded to fifty-one different naturalists and institutions. A list of these is also appended.

Recently a new department has been added to the station. Through this naturalists will be enabled to obtain mounted specimens of microscopic animals, viz., sections of embryos of all kinds of fishes, &c., preparations of larvæ or other animals too small for being sent in alcohol or other preservative solutions. Next year a catalogue of these specimens will be published, and the station will be prepared to send the specimens to any naturalist requiring them.

Trials of diving by means of the new Scaphander apparatus have also recently been made with very satisfactory results.

The aquarium of the station is being in part reconstructed, with some important new features, viz., moveable rockwork, for saving and examining the different animals which thrive by themselves on these rocks. This will enable statistical notes to be established on the growth of these animals, and on such changes as may occur by changing their habitat, inasmuch as these rocks may be replaced in the sea at different depths.

The following monographs are in preparation by workers in the station:—Ctenophoræ, Fierafer, Balanoglossus, Sipunculoidæ, Capitellidæ, Planariæ, Nemertineæ, Pycnogonidæ, Caprillidæ, and on several families of Algæ.

Three parts of the "Mittheilungen aus der zoologischen Station zu Neapel, zugleich ein Repertorium für Mittelmeerkunde" have been published, containing sixteen papers illustrated with many very carefully executed plates. Further parts are in active preparation.

It is, moreover, intended to publish the following works:—

"Fauna und Flora des Golfes von Neapel und der angren-

zenden Meeresgebiete." Folio. Yearly, 1 volume with 10–20 plates. The first volume is already in the press.

"Prodromus Faunæ Mediterraneæ." A selection from the whole zoological literature of short Latin diagnoses of the animals found in the Mediterranean, with their habitats and local names.

"Zoologischer Jahresbericht." This will contain short notices on the various memoirs and papers published in various countries on the subjects of zoology, development, and comparative anatomy. It is under the editorship of Prof. Carus, with the assistance of four collaborateurs in different countries. One volume will appear yearly.

Two naturalists have occupied the table hired by the Association, viz., Mr. Walter Percy Sladen and Mr. Patrick Geddes. Mr. Sladen has sent in a report on his stay and his work, which is appended. In this report he proposes "a means by which the table might be even more frequently occupied than it has been, and its sphere of utility thus extended, by suggesting to the consideration of the Committee that a further additional grant might be made by the Association, which would serve as a travelling fund. This might be apportioned in moieties say of 25*l.* to naturalists who desired to avail themselves of such assistance, and it is not improbable that many a student would by this means be enabled to participate in the advantages of the table at Naples, who might otherwise be deterred by the expense of the journey. The plan, extended or modified according to circumstances, is one adopted by several of the foreign bodies having tables at the Zoological Station."

Mr. Patrick Geddes worked at the station from February 26 to April 4. He "repeated and extended certain observations on echinoderm histology, and made experiments on *Bonellia viridis* and *Idotea viridis*, with a view of ascertaining the function of their (supposed) chlorophyll." The results of these studies are at present being published in the *Archives de Zoologie expérimentale* of M. de Lacaze Duthiers, viz., "Etudes sur le Chlorophylle animale," "Observations sur le Fluide périviscérale des Oursins."

Mr. Geddes also gained information on the working of the station, in the hope (now realised) of helping to found a zoological station in Scotland. This station is now in working order at Stonehaven.

Mr. Arthur Wm. Waters, who worked at the Association table last year, intends again to apply for the appointment to occupy it, with a view of extending his researches on the bryozoa of the Bay of Naples, already published in the *Annals and Magazine of Natural History*, 1879.

Your Committee think that the above particulars are sufficiently encouraging to induce the Association to renew the grant of 75*l.* for the ensuing year.

Report on the Occupation of the Table, by Mr. W. Percy Sladen.—In conformity with the requirements of the Committee of the British Association appointed in connection with the Zoological Station at Naples, I beg to submit the following report concerning my occupancy of the table which I had the privilege of using.

In availing myself of the opportunity of working at Naples, the main object which I had in view was that of studying the premature stages of the echinodermata, and more especially the growth-phases which intervene between the period when the pluteus is resorbed and that at which the adult characters are developed—the range and significance of these changes being very important and remarkable throughout the group. In addition to this chief object, it is scarcely necessary to add that there were numerous points in the morphology of echinoderms upon which, as a specialist, I was anxious to direct my attention, should time and opportunity permit.

I arrived in Naples on December 3, 1878, and remained there until February 17, 1879. During the greater portion of the time the weather was very inclement and stormy; in consequence of which the pelagic larval forms that I had hoped to have met with, by use of the surface-net, were driven to too great a depth, and owing to their microscopic proportions became thus altogether inaccessible. For this reason I was greatly disappointed in my expectations, and the material which I was able to obtain, in any way available for my projected investigations, was unfortunately very scanty; nevertheless several premature forms of considerable interest were procured, and these I am hoping still further to elucidate, before the end of the year, by finding, if possible, the corresponding and intermediate stages on our own coasts, and which will then enable me to work out the development of at least one or two forms completely. I also endeavoured to contribute somewhat to this subject by means of the artificial fertilisation of ova in several different families, but was always unsuccessful in keeping the *plutei* alive beyond a certain stage; whilst the fact that those thus raised in confinement were subject to very considerable abnormality in their development and present unnatural modifications which require much care and skill in elimination, in order to avoid error in subsequent deductions, greatly diminishes the utility of such observations as a direct method of embryological study, although they are not without value as furnishing some indication of the plasticity inherent in a given form.

Better success rewarded what I may speak of as desultory investigations upon the general structure of echinoderms. I may mention that I have in hand a contribution to the knowledge of *Pedicellariæ*, which I consider will throw light (if not entirely, at least in part) upon the functions of these obscure appendages. It was also my good fortune to discover in certain asteroids an hitherto undescribed organ, most probably performing sensorial functions; an account of which I hope to publish shortly, as soon as time permits me to work up the material which I collected more exhaustively than I was able to do whilst staying at Naples. In addition to the above I am also hopeful of furnishing a communication upon the premature anatomy of certain young echinoderms, for which purpose I was able to preserve and bring back with me several very good series of specimens.

The general success and continually increasing prosperity of the Zoological Station at Naples are now so fully known from the reports and various publications emanating from the institution itself, that it would be presumption on my part to offer any remarks in such a direction. I consider, however, that it is a duty for me to bear my individual testimony to the admirable arrangements which characterise the working of the station, and which conduce so greatly to the comfort of naturalists engaged in studying there. The daily supply of fresh material, the tank and aquarium accommodation for keeping the same alive, are highly satisfactory, and leave little to be desired; whilst in the way of ordinary laboratory apparatus and reagents no reasonable requirement is unprovided for.

I also desire to record my indebtedness for the genial kindness and the ever-ready assistance which I met with not only from Dr. Dohrn and the acting director Dr. Eisig, but the same friendly spirit of courtesy and help was accorded me without exception by every gentleman connected with the staff.

The utility of the Zoological Station being now so thoroughly established, and its reputation world-wide, it is unnecessary for me to allude to the fact, except to point out that the maintenance of such an undertaking is very costly, and that of necessity the results can only be continued by keeping up the funds. So much good work has already emanated from the station at Naples that the institution has a fair claim not only upon biological specialists, but on every one interested in the advancement of science. Upon such an argument, therefore, the Zoological Station is particularly worthy of the support of the British Association, even if its members were not (as many of them have already been) individual participants in the advantages which the station provides; and on this ground I would strongly urge the continuance of the grant usually made by the Association.

I would further beg to propose a means by which the table might be even more frequently occupied than it has been, and its sphere of utility be thus extended.

In conclusion I desire to express my cordial thanks to the Committee of the British Association for the privilege of using the table at their disposal. W. PERCY SLADEN

Exley House, near Halifax, August 2

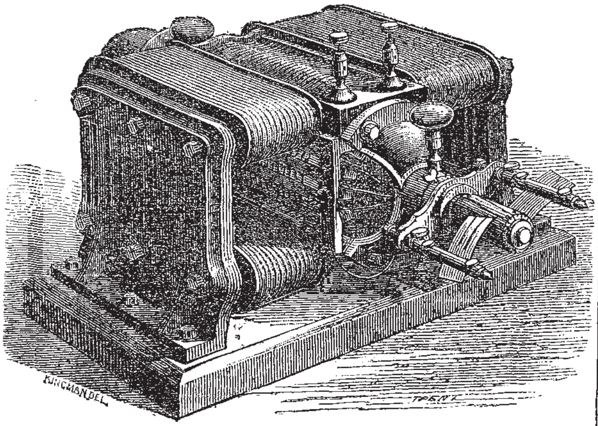
[A list of the naturalists who have worked at the Station, and of those to whom specimens have been sent during the past year, will be printed in the *Annual Report.*]

SECTION A—MATHEMATICAL AND PHYSICAL

On the Cause of the Bright Lines of Comets, by G. Johnstone Stoney.—Dr. Huggins and other observers had seen the bright lines of the carbon spectrum in the spectra of several comets. This established the fact that some compound of carbon was present in comets. In what had been hitherto written on this subject it had always been assumed that the compound of carbon was incandescent, and on that account emitted these bright lines. Mr. Stoney suggested, however, an alternative hypothesis which he believed to be entitled to much weight, viz., that these lines

were due to the sun's light falling upon the compound of carbon and rendering it visible, in the same way that light renders the moon, the planets, and other opaque objects visible, the vapour of carbon being opaque in reference to the particular rays, which appear as bright lines in its spectrum.

On Improvements in Dynamo-Electric Machines, by W. Ladd.—My object in this communication is to describe in a few words



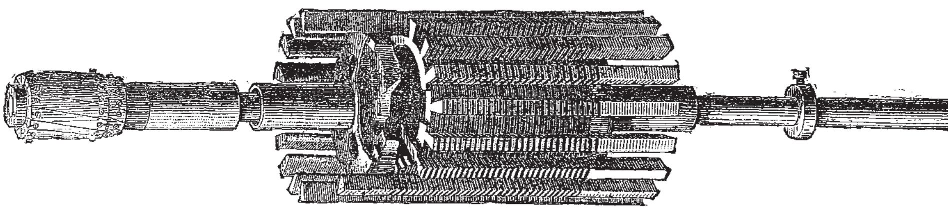
Weston's Dynamc-Electric Machine.

the peculiarities and improvements in the construction of Weston's dynamo-electric machine.

The Field Magnets.—The general appearance and arrangement of which may be seen in the illustration. The pole pieces are composed of iron plates, placed side by side in a mould, but separated a uniform distance from each other. The iron magnets, on which the wire is to be wound, are cast on to "lugs," or projections on the ends of the plates. The two cast-iron ends and uniting plates form one magnet; the upper and lower magnets are alike, and when joined together by the perforated vertical supports, the inner curved edges of the field plates embrace about two-thirds of the circle in which the armature is made to revolve.

The armature is built up of plates which are somewhat like a cogged wheel in shape (see illustration). These plates are stamped out of sheet-iron, and when mounted on the shaft are separated from each other at a uniform distance; the radial projections are then arranged in lines, so that the whole forms a very broad cogged wheel, or cylindrical structure having longitudinal grooves, with transverse spaces at regular distances. The longitudinal grooves are for carrying the wire, and it will be observed from the nature of the structure that the wire lies in channels three sides of which are iron; so that the mutual effect upon each other is increased as much as possible. The ends of the wires are connected to the field magnets and commutator in much the usual way, the currents travelling in one direction only. The commutator is fitted on a portion of the shaft which projects beyond the bearings. This admits of its easy removal and a new one being replaced in three minutes.

Another important feature in the construction is the arrangement for ventilation; the separation between the pole plates of the field magnets, the perforation in the vertical supports of the magnets, and the light frame-work of the armature, are all for this purpose. The air enters the centre of the armature, and is



Armature of Weston's Dynamo Electric Machine

driven out between the layers of wire through the spaces formed by the separated plates of the armature and the field magnets, and thus prevents any part from becoming unduly heated.

Machines of this description are made of various sizes and strengths, and give from one to sixteen lights in single circuit.

On the Direct Motion of Periodic Comets of Short Period, by Prof. H. A. Newton.—The periodic comets of short period, that is, the comets certainly seen at two returns, twelve or fifteen in number, have, all but one or two, small inclinations to the ecliptic; Halley's comet is an exception, being nearly retrograde in motion. Perhaps we may add the comet with which the November or Leonid meteors are connected (1866, I), since it is, I think, almost certainly identical with the comet of 1836, and has an inclination of about 163°.

The direct motion of the periodic comets seems to give them a peculiar relation to the solar system, even suggesting for them an origin common in some way with the origin of the planets. The other comets apparently come to us from outside the solar system, and if in any cases they are permanent members of the solar system, they have become such by the perturbations of the planets. Can it be that such perturbations have also forced the periodic comets into their present orbits?

The ordinary perturbating forces are small, and would almost as frequently increase as diminish the inclination of a comet's orbit. To every comet passing on one side of a planet, and so having its inclination diminished, there should be among an indefinitely large number of comets a second comet passing on a symmetrically opposite side, and having its inclination increased. But if we state the question properly, we get a different answer. If an indefinitely great number of comets approach and pass a large planet, and if the directions and lines of motion are uniformly distributed, some of those coming near to the planet will be turned into orbits of short period. Considering only the orbits thus affected, will they have in general small inclination? I find that they will, and that therefore we are not required, because of their different motions, to consider the periodic comets of short period as different in genesis from those of long period, or from those having parabolic orbits.

The conclusion suggests the possibility of a common outside origin to the periodic comets and the asteroids. It also suggests the possibility of an outside origin for the matter that makes up the zodiacal light, since it would explain the near coincidence of the plane of this mass with the ecliptic, notwithstanding its outside origin.

If, in addition, we may admit a like origin for the satellites, and even for some of the smaller planets, we are rid of the difficulty that seems to me insuperable, of supposing, as is usually done, that the very small bodies become solid from a nebulous state in the immediate presence of the sun and large planets.

On Self-acting Intermittent Syphons and the Conditions which Determine the Commencement of their Action, by Rogers Field, B.A.—In an extensive series of experiments which the author tried some years ago on syphons, with their outer legs dipped in water, he was much puzzled by finding that the quantity of water necessary to put a syphon of given size into action varied in the most unaccountable way at different times. The only difference that could be perceived between the cases in which the syphon started and those in which it did not start was, that in the former case air-bubbles escaped freely at the mouth of the syphon, whereas in the latter case, under apparently the same conditions, very few bubbles came out. At last the idea suggested itself of making a portion of the syphon in glass, so as to see what was going on inside the pipe, when the course of the irregularity was at once discovered. Sometimes the water which ran over the bend adhered closely to the sides of the pipe, at other times a portion of it would fall more or less clear of the sides. When the water adhered to the sides it produced very little effect in displacing the air, so that only a small quantity of air was driven through the water at the mouth of the syphon. When on the other hand the water fell clear of the sides, it produced a great effect in displacing the air, and large bubbles of air at once escaped from the mouth of the syphon.

The investigation was pursued further by producing artificial irregularities in the pipe, and it then appeared that the more completely the water could be thrown clear of the sides of the pipe, the greater effect it produced in expelling the air and starting the syphon.

The author applied this and other principles in his intermittent syphon, of which a working model was exhibited, and which was illustrated by diagrams. Self-acting syphons have been used in emptying vessels for measuring water, as in Osler's and Bickley's self-recording rain-gauges; and the syphon described might be so employed and also in a more practical manner, such as for flushing sewers by water which usually runs to waste.

Mr. W. E. Ayrton read a paper by Dr. Muirhead *On the Constancy of the Capacity of Certain Accumulators*, and a note thereon by Mr. C. Hockin. The latter communication contained an account of observations which were first begun with the object of redetermining the capacity of certain condensers employed in the testing of cables, and in terms of which the capacity of many cables now submerged have been recorded and published. In consequence of these papers a committee was appointed by the Association, on the recommendation of Section A, for the purpose of deciding upon an authoritative standard of electrical capacity.

Prof. G. Forbes made some remarks upon *The Bursting of Firearms, when the Muzzle is closed with Earth, Snow, &c.*—This well-known fact was explained in a simple manner. If the charge moved slowly, of course very small pressure of air would drive out the obstacle, which offered a very small resistance; but in practice the charge travelled with a speed of more than the velocity of sound. The mathematical investigation showed that the pressure generated with a plug of the density of air is $7\frac{1}{2}$ tons. The complete investigation is to be found in the *Proceedings* of the Royal Society of Edinburgh.

The Section devoted Saturday as usual to the mathematical papers, which were not so numerous as they have been in recent years.

Mr. H. M. Jeffery gave an account of his work *On Plane Class Cubics with Three Single Foci*, which concluded his enumeration of curves of the third class; and Mr. W. H. L. Russell communicated a theorem *On Linear Differential Equations.*

Mr. J. W. L. Glaisher gave an account of *Some Enumerations of Primes of the Forms* $4n + 1$ *and* $4n + 3$, referring to the investigations of Prof. Tchebycheff, who had shown that primes of the form $4n + 3$ were more numerous than those of the form $4n + 1$, the difference in the numbers of primes of the two forms up to a certain large limit x being for certain values of x of the order $\frac{\sqrt{x}}{\log x}$. Mr. Glaisher also communicated an elementary method of summing the series

$$\tan^{-1} x^{2n} + \tan^{-1} \frac{x^{2n}}{2^{2n}} + \tan^{-1} \frac{x^{2n}}{3^{2n}} + \&c.,$$

and similar series, and also some formulæ in elliptic functions.

Mr. A. J. C. Allen read a paper *On some Problems in the Conduction of Electricity*, the principal object of which was to solve the problem of the conduction of electricity in a spherical current sheet, the electricity being introduced and carried off from the sheet at any number of points, called electrodes; and also to do the same for certain finite portions of a spherical sheet, bounded either by current or equipotential lines, the motion being in all cases steady. This was effected by means of a theorem, which was then applied to deducing solutions for a number of finite areas on the sphere. The case of one source and an equal sink on a complete sphere was discussed in detail, and the current and equipotential lines shown to be two systems of small circles. A similar theorem, though not quite so universal in its application, was shown to hold for a sheet in the shape of a circular cylinder. The paper concludes with a solution in singly infinite series of the problem of the conduction of electricity in a plane area, bounded by two concentric circles, and also in that bounded by two concentric circles and two radii, meeting at an angle $\frac{\pi}{n}$ (n integer).

SECTION B—CHEMICAL SCIENCE

Notes on Recent Spectral Observations, by J. N. Lockyer, F.R.S.—The following results have been obtained by the method recently described to the Royal Society (*Proc.* R.S., vol. xxix. p. 266:—

1. Carefully distilled sodium condensed in a capillary tube, and placed in the retort, gives 20 volumes of hydrogen.
2. Phosphorus carefully dried gives 70 volumes of gas, chiefly hydrogen, which, however, is not PH_3, although it gives some of the lines of phosphorus. It is not PH_3, because $CuSo_4$ is not touched by it.
3. Magnesium carefully prepared by Matthey is magnificent in its colourings; we get first hydrogen, then the D line [not sodium, for the green line is absent], then the green lines of magnesium, (*b*) then blue line, then various mixtures of all of them, as the temperature is increased, D being always the brightest, 2 volumes ($\frac{1}{2}$ *cc*) of hydrogen only were collected.
4. With gallium and arsenic the pump always clicks, indicating that no gas is given off.
5. From sulphur and some of its compounds there is always So_2.
6. From indium, hydrogen comes over before heating.
7. Lithium gives 100 volumes of hydrogen.

The conditions of the experiments have always been the same, the only variable being the substance. The volumes stated are those generally obtained; almost all experiments are ended by the cracking of the tube.

On large Crystals of Mercury Sulphate, by Philip Braham.—Mr. Braham exhibited crystals which had taken over two years in forming, and were due to the presence of a trace of nitric acid in the sulphuric acid in which they were formed.

On the Manufacture of Crucible Steel, by Henry S. Bell, F.C.S., &c.—The manufacture of crucible steel is one of the most important industries connected with the town of Sheffield, which boasts of not less than 120 firms engaged in the production of this material. Notwithstanding the enormous output of steel by the Bessemer and Siemens-Martin processes, this kind of steel is unrivalled for the manufacture of the finer varieties of cutlery and edged tools, &c. A brief outline of the process itself is as follows:—The most of the iron employed for this purpose is imported into this country in the shape of bars from Sweden, where it has been smelted from very pure iron ores, in a blast furnace, by the aid of charcoal, and subsequently puddled to free it from impurities.

The first operation to which it is subjected, is that known as the cementation or converting process, the object of which is to combine a certain quantity of carbon with the iron; this operation is performed in a furnace of peculiar construction, where the iron and charcoal are packed together in air-tight chests or converting pots, subjected to a high temperature short of the fusing point of iron, where it remains for a matter of three weeks.

After the conversion, when the pots are cold the bars are taken out and found to be covered with blisters, hence it is termed blister steel. In consequence of the various theories proposed to account for this peculiar formation, the writer was induced to make a series of investigations. For this purpose he was kindly furnished by Messrs. Seebohm and Dieckstahl, of the Dannemora Steel Works, with some samples of this blister steel, various portions of which he submitted to analysis, the results of which showed a marked increase of silicon where the blisters occurred.

On inspecting one of these bars of blister steel, it is found that it has undergone both a physical and a chemical change.

The iron has now assumed a crystalline structure, and has chemically combined with a certain amount of carbon. This latter change commences on the exterior, and extends itself to the interior of the bar, if the process be continued sufficiently long, thus showing that carbonic oxide never penetrates into the centre of the bar, until the whole is converted into steel.

The writer is indebted to the kindness of the above-mentioned firm for a sample of bar iron, before and after conversion, in order to ascertain the exact chemical change that took place during the process. The following are the results obtained:—

	Before Conversion	After Conversion
Fe	99·471	98·603
C	0·352	1·250
Si	0·050	0·035
S	0·027	0·022
P	0·025	0·018
Mn	0·075	0·072
	100·000	100·000

The decrease in impurities appears greater than it really is, owing to the fact that the bar itself has increased in weight by the addition of carbon.

One remarkable fact is that, after the conversion of the iron, a quantity of the charcoal, in the converting pots, is found in a pulverised state, so as to be unfit for further use.

Some of this waste charcoal the writer has examined, and from one sample, by the aid of a magnet, he succeeded in extracting 5 to 6 per cent. of iron scale, and small pieces of steel, these on being treated with dilute hydrochloric acid, evolved considerable quantities of sulphuretted hydrogen; in one case he estimated the quantity of sulphur, and found it to contain as much as 1·25 per cent. of this element.

The steel is now broken up into small pieces and melted in crucibles, and cast into ingots. These are sent to the forge, where they are heated and rolled. In this part of the process the chief difficulty with which the silter has to contend is the porous or "honey-combed" structure of the steel.

One of the characteristic features relied on by practical men as indicating the quality of a piece of steel is the appearance of its fracture; but this is by no means an infallible test, as the fineness or coarseness of grain can be produced by mechanical treatment or chemical means.

The characteristic property possessed by steel is its capability of being hardened and tempered. The temper of cast steel may be said to range from 0·75 to 1·50 per cent. carbon. The temper of steel is an important question in connection with the purpose for which it is required; thus a steel containing 1·50 per cent. of carbon is the class employed for razors. 1·25 per cent. is that known as "tool temper." Steel containing 1·00 per cent. carbon is termed "chisel steel," and this temper is extensively used in the arts.

The latter part of the paper is occupied with the consideration of the manner in which bodies such as carbon, silicon, sulphur, phosphorus, and manganese, affect the quality and mechanical properties of the steel.

A Lecture Experiment in Illustration of the Hollway Process of Smelting Sulphide Ores, by Alfred H. Allen.—By causing oxygen gas to bubble through molten antimony sulphide contained in a V-shaped piece of combustion-tube, combustion takes place with such rise of temperature as to soften the glass, while a sublimate is obtained of antimonious oxide, and sulphurous acid gas is evolved. The sublimate is collected in an empty globe, and the sulphurous acid is absorbed by passing it into a large vessel containing lumps of wood-charcoal. At the conclusion of the experiment the contents of the combustion-tube may be poured out, when a button of metallic antimony free from sulphur is obtained.

By passing oxygen over lumps of pyrites contained in a heated combustion-tube, vivid combustion takes place, much free sulphur sublimes, and sulphurous acid gas is obtained and absorbed as before described.

On the Presence of Nitrogen in Steel, by Alfred H. Allen.—The author made some preliminary experiments on the subject in 1872, but has only recently obtained any definite results. The method adopted has been to dissolve the steel in hydrochloric acid, by which means any combined nitrogen may be presumed to be converted into ammonia. The solution obtained was then distilled with excess of lime, and the distillate examined for ammonia by Nessler's method. The employment of this extremely delicate test enabled the author to operate on a much smaller quantity of steel than was employed by previous investigators. Very special precautions were taken to obtain the hydrochloric acid and other materials free from any trace of ammonia or nitrous compounds, and the air was entirely expelled from the apparatus before commencing the operation. The hydrogen evolved was freed from any traces of ammonia by passing it through a tube filled with glass beads moistened with hydrochloric acid. It was proved by blank experiments that no source of ammonia existed in the reagents or apparatus.

When absolutely pure materials were used, and every precaution taken to get rid of the contained air and other sources of error, the addition of Nessler's solution to the liquid obtained on distilling with lime caused a very marked yellowish-brown coloration.

The author then gives the amount of nitrogen determined by his method in different varieties of steel.

In order to obtain ammonia in quantity sufficient for its recognition by other reactions than that with Nessler's test, the following plan was employed:—

Steam, generated by boiling water in a flask, was passed over a considerable quantity of steel borings contained in a combustion tube which was bent beyond the furnace, and prolonged so as to form the inner tube of a Liebig's condenser. To the further end, a tube filled with glass beads and furnished with a glass stopcock was attached. A rapid current of steam was driven through the apparatus for a considerable time to expel every trace of air. On condensing the steam it was found free from any trace of ammonia. The steel borings were then heated to redness by a combustion furnace, and a rapid current of water passed through the condenser. The condensed steam, when tested by Nessler's solution, was found to contain abundance of ammonia, which did not diminish in amount till the borings were almost entirely oxidised. On redistilling the condensed steam, a distillate was obtained, having a distinctly alkaline reaction to litmus paper, and on treating it with hydrochloric acid and platinic chloride a sensible amount of yellow precipitate was obtained, having the characteristic crystalline form of ammonium chloroplatinate. The amount found was larger than could possibly have been produced had the whole of the nitrogen of any residual trace of air been converted into ammonia.

The author regards the results now recorded as preliminary merely, and proposes to extend the research to various classes of steel and iron, and especially to such specimens as have been found to possess anomalous characters. Of these, the evolution of ammonia from freshly fractured surfaces is the most striking.

On the Separation of Phosphorus in Steel Manufacture, by Thomas Blair.—He said the complete removal of phosphorus from pig-iron is of the utmost importance to this country, as the greater portion of ores raised and iron made here is unfit for the manufacture of steel by the Bessemer processes. A history of the various processes made use of for the purpose were examined in detail, especially the processes of Messrs. Bell, Thomas, and Gilchrist. The writer concluded that this latter process was in a fair way to succeed commercially, and that it seemed only necessary to effectually remove a few remaining difficulties.

SECTION C—Geology

On the Coal Fields and Coal Production of India, by V. Ball, M.A., F.G.S., of the Geological Survey of India.—The coal-bearing rocks of Peninsular India are all included within the limits of the great series of plant-bearing rocks to which the term Gondwana has been applied, and they are further limited to two groups of rocks which occur in the lower portion of that series.

By some authorities the age of these Gondwana rocks is supposed to be equivalent to that of the European formations which range between and include the lower oolite and the base of the trias (Buntsandstein). By others the lower measures, including the coal, are believed to be palæozoic. The author proceeded to give an outline of the recent discussions on this subject, referring particularly to Mr. W. T. Blandford's judicial summary of the evidence in the lately issued "Manual of the Geology of India."

The distribution of the coal-bearing areas was then pointed out on a series of maps which were exhibited, and the number of distinct coal-fields was stated to amount to about thirty. Some details were then given regarding these fields, of which five only are worked at present, namely, Ranigunj, Kurhurbali, and Daltongunj in Bengal, and Mopani and Warora in the Central Provinces.

The total area of the Indian coal-fields is estimated by Mr. Hughes at upwards of 30,000 square miles. Three countries alone contain larger areas, viz., the United States 500,000, China 400,000, Australia 240,000.

In quality the Indian coals are inferior to the average of English and Australian; but they are capable of accomplishing good work in locomotives, and for this purpose they are largely employed on the main lines of railway in India—Indian coal mixed in equal proportion with English.

The author proceeded to give further details as to the quality of the coal, stating that the anthracite varieties were rare, the general character being bituminous and the structure laminated—bright and dull layers alternating.

In round figures it may be stated that at present 1,000,000 tons of coal are consumed in British India *per annum* in locomotives and factories, the quantity employed in the form of coke for domestic purposes being inconsiderable; and that of this 1,000,000 tons, about one-half is raised from Indian mines, the other coming from England, France, and Australia.

On the Keuper Beds between Retford and Gainsborough, by F. M. Burton, F.G.S.—After describing the general position of

the beds in relation to the triassic system, and remarking on the absence of the upper mottled sandstone, as well as the "Muschelkalk," in this part of England, the author described the various strata of the district, as shown on the line between Retford and Gainsborough, and pointed out the want of any division in the beds of the lower keuper sandstone, as in other localities, and the absence of any boundary line between this series and the "red marls" above.

On a Northerly Extension of the Rhætic Beds at Gainsborough, by F. M. Burton, F.G.S.—At the meeting of the British Association at Nottingham in 1866, the author announced the discovery of beds of the rhætic age at Gainsborough, a full account of which will be found in the *Quarterly Journal* of the Geological Society for 1867. These beds occur to the south of Gainsborough, on the Great Northern line between Doncaster and Lincoln, and were discovered through the lowering of the gradients of that line in 1866. The author has since found them in a cutting of the Manchester, Sheffield, and Lincolnshire Railway at Blyton, about five miles to the north of Gainsborough, where they must have been exposed since the making of that line in the year 1848, though hitherto they have remained unrecorded.

The Age of the Penine Chain, by E. Wilson, F.G.S.—In this paper the author combated the generally accepted view of the post-Permian origin of the Penine chain, and contended for a pre-Permian upheaval. In support of this opinion the following facts were cited: The Yorkshire coal-basin was admittedly pre-Permian, for north of Nottingham the magnesian limestone everywhere overlaps the coal measures; but the axis of this basin is parallel with the Penine chain, and was evidently determined by the same series of movements that upraised that chain. The Permians disappear on the west in approaching the Penine chain; in this direction also the marl slates attenuate, and these and the magnesian limestone become more sedimentary, as if approaching a margin. Mountain limestone pebbles occur in Permian breccias on one or both sides of the Penine axis. Many fragments of carboniferous rocks occur in lower Bunter sandstone (breccias) on the borders of Notts and Derbyshire; but the author finds no fragments of Permian rocks in these breccias. No outliers of Permian rocks are found at any distance west of the magnesian limestone escarpment between Nottingham and Northumberland. The character and succession of the Permians on the two sides of the Penine chain are very dissimilar.

On Geological Episodes, by J. F. Blake, M.A., F.G.S.—Geological nomenclature was first founded on the theory of universal deposits; then the idea of lateral changes was introduced, with the necessary misuse of lithologically descriptive names; ultimately all deposits were seen to have their boundaries. Beds deposited in distinct areas can thus be proved only homotaxial, and these are by no means necessarily synchronous. The object of this paper is to show that a somewhat similar principle ought to govern all our geological classification. A single area is defined to be one over which we can trace one or more related formations consecutively, and which formations contain identical characteristic fossils. Deposits in single areas may be compared as to time and divided into life zones; but these in different areas are homotaxial only. In each single area the outlines and characters of the several deposits must first be determined and denoted accordingly.

In studying any group of rocks in a single area it is seen that some members have a much wider range than others. Such differences in range are accompanied by marked differences in character and point to differences in the circumstances of deposit. The wide-spread formation indicates uniform changes of level over the area and a mixture of deposits—such circumstances may be called normal. But mere local changes may bring more restricted areas into peculiar physical conditions. Such local changes may be called "geological episodes," and they will result in the formation of deposits of marked character easily distinguishable from the normal.

The first point is to determine the characters by which an episodal deposit may be differentiated from a normal one. The supreme test is that derived from its definition, *i.e.* its local development; but if it be very small, it may be insignificant; if relatively very large, the distinction may be of no consequence. As a rule argillaceous rocks are normal, and arenaceous and calcareous episodal; but this is by no means universal. When the normal formation of a period is determined, the episodes are marked by their differing mineral nature. The two kinds of deposits may also be determined by the nature of their fossils, after we have first discovered what kinds of fossils are usually episodal. For this purpose those fossils which are found in all kinds of rocks, and therefore appear to have been indifferent as to their physical surroundings, may be called *invariant*, and those found only under particular conditions, and which change their locality as these conditions change, *covariant*. Invariants only are suited for zonal classification; covariants are characteristics of episodes. A table is drawn up showing the classes, families, and genera which may be covariant, according to the imperfect observations of the past. The chief covariants are a few foraminifera—the sponges—a large number of hydrozoa and actinozoa, some crinoids, the blastoids, a few lamellibranchs, and at least half the gasteropod families.

The main proposition is that *similar, but distinct episodes, in a normal series of strata are neither necessarily nor probably of the same age*. The true method of geological classification is therefore to arrange only the normal deposits in a series by their stratigraphy and their invariant fossils, while the episodes are put in their place as such.

These doctrines applied to British strata yield the following results: No episodes are recognised in Cambrian or pre-Cambrian rocks. In the lower Silurian, the Durness limestone, the Llandeilo flags, the Bala limestone and the Caradoc sandstone, and the May Hill and Llandovery beds are characterised as such. Hence the term "Caradoc" is inapplicable as a name for the normal portion of the series. The "Colonies" of Barrande may be episodes recurrent on the same area. In the upper Silurian, the Wenlock and Aymestry limestone, the Denbigh grits, and tilestones are episodes. The carboniferous series present us with the Coomhola grits, Burdie House limestone, Millstone, and Pennant grits, while the mountain limestone is merely a gradually changing normal deposit. The episodes of the Permian are the fossiliferous limestone and underlying marl slate. The absence of the Muschelkalk from England is not regarded as due to its being an episode, but to our deposits as a whole being formed in a distinct area, the true episodes of the period being the Hallstadt, St. Cassian, and Dachstein beds. The lias is remarkable for its great freedom from episodes, which accounts for the success of its zonal classification, the only exceptions being the Sutton series, and some of the middle lias rock beds. The lower oolites, on the contrary, are almost entirely episodal, none of the beds having a wide range. The Yorkshire deposits were formed in a distinct area, and may cover the period of the great oolite as well as the inferior oolite, the deposits supposed to connect them with the latter being episodes. The rocks above the Cornbrash formed one connected series, as recognised by all German writers and some French, in which the Kelloway rock, the Corallian, and the Portland rocks are well-marked episodes in this country. It is therefore suggusted that the term "middle oolites" should be abolished from the classification of British strata, and the whole be known as upper oolites. The various episodes in this series on the Continent and in England will never be truly located until their real character is seen, and it has been by the study of these rocks that the doctrine of episodes has been suggested.

In the cretaceous series the wealden, the Tealby series, and parts of the lower greensand are episodal, the ironsands being the nearest approach to a normal formation. The upper greensands are also episodes; but the chalk, though calcareous, is normal.

The lower tertiaries, like the lower oolites, scarcely present any normal deposits, the London clay being, though argillaceous, episodal in character.

In the result, the series of sedimentary rocks should be represented not by so many parallel lines, but in many cases by lenticular masses, whose age is denoted by their position—according to a table which presents their true character. It is urged, therefore, that the names proposed—or else some better—be used to distinguish the different kinds of strata and fossils, in order to give definition and importance to truths which must have long been floating in the minds of geologists.

The Surface Rocks of Syria, by J. Perry.—The paper was suggested by an examination of the sandstone quarries at Baalbec. The rock is composed of a mixture of the particles of limestone from the coast, and drift-sand. The mixture is consolidated layer by layer, and fresh rock of the same nature is now in process of formation. The author explained how the consolidation is produced by water dissolving the particles of carbonate of lime and by alternations of temperature. The author then gave some explanation of the veined and apparently cracked appearance of certain limestones.

On the Bone-Caves of Derbyshire, by Prof. W. Boyd Dawkins, M.A., F.R.S.—The first cavern discovered was that at Wirksworth in 1820, accidentally come upon in the workings of a lead-mine. Elephants, rhinoceri, &c., were found there. In 1875 the Rev. J. M. Mello explored the caves at Creswell Crags, which have yielded most important results. Amongst the bones found are those of hyæna, bison, reindeer, lion, hippopotamus, and bear, together with implements of flint and chert, and an engraved bone showing a sketch of the horse. The caves yield evidence of improvement in the manufacture of implements in succeeding dates. In 1876 Prof. Dawkins and Mr. Rooke Pennington explored the Windy Knoll, near Castleton. From the mode of occurrence of bones here, it seems clear that the bison was a summer or late-spring resident; the reindeer a winter one. A cavern near Matlock Bath was explored in 1879.

There is no evidence as to the age of these caverns; nothing to show that they existed before or during the glacial period. The author deprecated any attempt to place before the public a greater definiteness as regards the date of geological events than the facts warrant.

On Ammonites and Aptychi, by C. Moore, F.G.S.—The author gives evidence which renders it probable that the aptychus is not an operculum. It often occurs associated with numerous minute eggs; and the author suggests that, with the siphuncular tube, it probably represents an ovarian sac.

On the Classification of the British Pre-Cambrian Rocks, by Dr. H. Hicks, F.G.S.—The author divides the pre-Cambrian rocks into four groups under the following names, in ascending order:—1. Lewisian; 2. Dimetian; 3. Arvonian; 4. Pebidian.

1. *The Lewisian.*—So named by Sir R. Murchison to indicate the crystalline rocks of the Hebrides and north-west Highlands of Scotland, is retained to indicate the oldest group at present recognised in Britain, and largely developed in the Hebrides. It is found also in parts of the Malvern Chain, the north-west of Ireland, and possibly also in Anglesey. The prevailing rocks in this group are massive gneisses, in which hornblende and felspar are the chief ingredients, and quartz chlorite and mica but sparingly present. They are usually of a dusky red, grey, or dark colour. Sometimes almost a pure hornblende rock is found. The strike in these beds is usually east and west, or some point between that and north-west and south-east.

2. *The Dimetian.*—This group is largely developed in Wales, as at St. Davids, Caernarvon, Rhos Hirwain, and Anglesey. It has been found by Dr. Callaway in Shropshire, and I have recently seen it with him also in the Malvern Chain, especially in the Worcester Beacon. I noticed it also, last year, in large development at Ben Tyn, Loch Maree, and near Gairloch, in Ross-shire, as well as at several other points in the north-west Highlands of Scotland. The prevailing rocks in this group are granitoid and quartzose gneisses with pinkish, flesh-coloured, or white felspar, and with limestone, micaceous, and occasionally chloritic and hornblendic bands. Brecciated beds also occur, in which bits of the older Lewisian gneiss are sometimes found. The strike is generally north-west and south-east, or from this to north and south. It evidently overlies the Lewisian unconformably in the areas where both have hitherto been found associated; and its highly quartzose character and lighter colour generally, are in marked contrast to most of the members of that group.

3. *The Arvonian.*—At the last meeting of the British Association I mentioned, for the first time, the discovery, or rather the separation, of this group. It is largely developed in Pembrokeshire and Caernarvonshire. It occurs also in Anglesey and Shropshire, and I have recently found it at the base of the Harlech mountains. I have seen masses of it also from the Orkneys, and it probably occurs both in the Western Islands and in the Grampians of Scotland. It is the great hälleflinta group of the Swedish geologists, and the petro-silex group (Hunt) found so largely developed in North America. It is chiefly made up of quartzo-felspathic rocks, sometimes porphyritic, frequently brecciated, and of compact quartzose rocks or hälleflintas, which on microscopical examination have the appearance of incipient gneiss. The strike is usually about north and south, and it overlies the Dimetian unconformably.

4. *The Pebidian.*—This being the newest group in the pre-Cambrian rocks, is the least altered in character, and most nearly approaches in strike to the overlying unaltered or Cambrian rocks. It resembles that group in many of its rocks, and on that account was for a time supposed to be identical with it, only that it had undergone alterations. Now we know that it underlies the latter unconformably, and that the apparent similarity in character is to be attributed to the fact that most of the Cambrian rocks were derived from the denudation of this group. That it was also in a high state of alteration before the Cambrian rocks were deposited upon it is evident from the fact that an abundance of pebbles and masses of it occur in the conglomerates at the base of the Cambrian. It consists for the most part of chloritic, felspathic, talcose, and micaceous schistose rocks, alternating with massive and slaty greenstone bands, dolomitic limestone, turpentine, lava-flows, porcellanites, breccias, and conglomerates. It is traversed also frequently by dykes of granite, dolerite, &c. It is a group of enormous thickness, and is largely distributed over Great Britain. It occurs in many parts of Wales, in Shropshire, and in Charnwood Forest. I found it also last year in the north-west of Scotland; and I have seen specimens of it collected by Mr. Jas. Thomson and others from Islay, and others of the Western Islands. Dr. Hunt recognised it also along the Crinan Canal, and in the vicinity of Lough Foyle in Ireland. It is probably represented in America by the Huronian group. The prevailing strike is north-north-east to south-south-west, or from this to north-east and south-west. The conglomerates at its base are largely made up of masses derived from the Arvonian, and, at most of the points examined, it is undoubtedly unconformable to that group.

SECTION D—Biology

Department of Anatomy and Physiology

On a Visual Phenomenon and its Explanation, by Wm. Ackroyd, F.I.C. Abstract of the paper (A).—Visual phenomena are of general interest and are often described, but seldom explained. The phenomenon in question may be seen under the following circumstances. Face the breeze and without winking allow a small rain-drop to fall on the surface of the cornea, all the while keeping your gaze fixed on a lamp light some hundred feet away. As the raindrop alights on the cornea, several rings of light appear to surround the luminous source and *they gradually contract in diameter*. Explanation:

In sunshine, the moving ring-crest of water, produced by dropping a pebble into a still and shallow pool projects a ring of light on the bottom, which gradually increases in size. The moving ring-crest, by its refractive action, produces a hollow cylinder of rays of ever-increasing diameter, and we see a section of it on the bottom of the pool. The rain-drop falling on the cornea spreads out on its surface in several ring-crests, and would similarly produce a series of outward travelling rings of light were it not for the combined action of the refractive media of the eye. Under the influence of these two hollow cones of light are formed within the vitreous humour directly upon impact of the raindrop. The first of these has for its base a small circular area of the hind surface of the lens, and its prolongation; the second cone has the retina for its base. As any individual ring-crest spreads out on the cornea, the first cone increases in size, the common apex advances towards the retina, and consequently the section of the second cone projected on to the retina decreases in size and appears as a contracting ring of light.

Department of Zoology and Botany

Prof. Ray Lankester read a paper, *On a Case of Disputed Identity—Haliphysema.*—The different views of Haeckel and others on this remarkable form were discussed, and its history traced. Prof. Ray Lankester, from a careful examination of recent specimens forwarded by Mr. Savile Kent, has no hesitation in stating that it is not a sponge but a curious rhizopod-like amœba with a test of sponge spicules curiously constructed like that of a caddis worm.

Prof. Westwood, M.A., read a paper *On the Insects which Injure Books.* Referring to an address delivered by Dr. Hagen, on July 2, 1878, before the American Library Association on the same subject, Prof. Westwood passed in review the life-history of the different species of insects which have been found to destroy books and printed papers, several of which were not noticed by Dr. Hagen. The caterpillars of the moth *Aglossa pinguinalis*, and also of a species of *Depressaria* often injure books by spinning their webs between the volumes and gnawing small portions of the paper with which to form their cocoons. A small mite, *Cheyletus eruditus*, is also found occasionally in books kept in damp places. A very minute beetle, *Hypothenemus eruditus*, forms its tiny burrows within the binding of books.

Lepisma saccharina also feeds on paper, of which a very curious example was exhibited of a framed and glazed print of which the plain paper was eaten whilst the parts covered by the printing ink were untouched. White ants, Termitidæ, are a constant source of annoyance in warm climates; and Prof. Westwood also noticed the ravages committed by the cockroaches, *Blatta orientalis*.

The insects that do the greatest injury are *Anobium pertinax* and *A. striatum*, commonly known as the death watches, burrowing through the books, even, it is recorded, drilling through 27 folio volumes.

Various remedies for the destruction of these insects were mentioned and especial notice was directed to a "Report of the Commission appointed to inquire into the Decay of Wood-Carvings, and the Means of Preventing and Remedying the Effect of such Decay," issued by the Science and Art Department in 1864.

Prof. Westwood then detailed the various remedies proposed, as washing with solution of corrosive sublimates in alcohol, exposing the books to the vapour of benzine, or carbolic acid, or hydrocyanic acid, or fumigating with burning sulphur. Placing the volumes under the exhausted receiver of an air pump for an hour, has been found successful by Dr. Hagen.

The Occurrence of Leptodora in England.—Sir John Lubbock called the attention of the Section to the occurrence in England of Leptodora, a very interesting crustacean first found in deep lakes abroad, and more recently in a reservoir near Birmingham. Like many marine organisations it was as transparent as glass. This rendered the creature less conspicuous to its foes. Like other animals of the same group it laid two kinds of eggs. The young at first were quite unlike their parents, so unlike that they had been thought to be a distinct species. Sir John then entered into a description of the little animal, and by means of sketches illustrated the peculiar functions of the different organs, pointing out the difference of the organs in male and female.

On the Homologies of the Cephalopoda, by J. F. Blake.—The flexure of the intestine in Cephalopoda and Pteropoda is "pedal," and that of other Odontophora, "cephalic;" and the body of a cephalopod must be placed with the mantle cavity horizontal for comparison with a gastropod. The arms are not homologous with the foot, but form an "antivelum." The labial and tentacular processes, and not the individual tentacles of a Nautilus are shown to be homologous to the arms of an Octopod. The hood is associated with the aptychus of the Ammonite, the shell of an Argonaut, and the neckplates of a Sepia. The Ascoceras is cited to show the relations of the sepia-bone to the nautilus shell.

On Cyclops, by Marcus M. Hartog, M.A., B.Sc.—The nervous-cord of Cyclops is essentially copepodan in type, it is not dilated into special ganglia, and contains no cellular elements beyond the third thoracic segment. It bifurcates in the second abdominal segment, and the branches terminate in the furca. The sensory and motor nerves appear to be wholly distinct, the latter coming off at a higher or deeper level. All the sensory nerve-fibres pass through a bipolar ganglion cell near their distal termination. Minute rounded spaces in the hypoderm, especially one at the base of the last thoracic limb, appear to be auditory organs. Respiration in Cyclops is entirely anal.

On Mimusopeæ, a Section of the Order Sapotaceæ, by Marcus M. Hartog, M.A., B.Sc.—In this paper the genus Dipholis is merged in Bumelia, and the genera Imbricaria, Labramia, and Muriea in Mimusops: a review of the deferential characters hitherto relied on showing their inadequacy from every point of view—even convenience.

On Fruits and Seeds, by Sir John Lubbock, Bt., V.P.R.S. M.P.—Sir John commenced by calling attention to the difference presented by seeds, some being large, some small, some covered with hooks, some provided with hairs, some smooth, some sticky, &c., and after observing that there were reasons for all these peculiarities, proceeded to attempt to explain some of the more striking. In the first place, he said, many seeds required protection from birds and insects; hence the shells or husks of the beech, Spanish chestnut, horse chestnut, walnut, &c. In some cases, as in the common herb Robert, the calyx, or outer envelope of the flower opens, when the flower expands, and closes over the seeds when the flower fades, and opens again when the seeds are ripe. In other cases the flower-stalk changes its position. Thus in the dandelion, it is upright when in flower, lies close to the ground after the flower has faded, and rises again when the seeds are ripe. In the cyclamen again, the flower-stalk curls itself up into a spiral after the flower has faded.

He then called attention to the modes of dispersion by means of which seeds secure a sort of natural rotation of crops, and are also in other cases enabled to rectify their frontiers. Some plants actually throw their seeds. Thus in the common cardamine, the outer membrane of the pod becomes very tense, and when ripe, at the least touch it gives way at the base, and curling up with a spring throws the seeds three or four feet. The common geraniums also throw their seeds, and so do some of the cucumbers, but in these cases the mechanism is different. He then described the curious "elaters" of the equisetums, and other means of dispersion possessed by seaweeds, and other low organised plants. Among the higher plants, the seeds are in many cases transported by the wind. Sometimes, indeed, the whole plant is thus blown about, as in the case of the celebrated rose of Jericho, an annual inhabiting the sandy plains of Palestine, Syria, and Arabia, which when dry curls itself up into a ball, and is thus blown over the surface of the ground till it comes to a damp place when it uncurls, the pods open and shed their seed.

Many seeds are provided with a wing which catches the wind and thus aids in dispersion. Such seeds occur especially on trees, such as the pine, fir, ash, maple, sycamore, hornbeam, and many exotic species. In these cases the seeds are large, but many herbs have small seeds provided with foliaceous expansions serving the same purpose. These are sometimes so thin as to be transparent; and in *Thysanocarpus elegans*, the membrane is even perforated by a series of holes. In other cases the seeds are provided with hairs which catch the wind, sometimes forming exquisite fairy parachutes. Such for instance are the dandelion, &c., but it is curious that very different parts of the plant are modified into these hairs: thus in the dandelion and valerian it is the calyx, in the bullrush the perianth, in the willow-herb the crown of the seed, in the cotton-grass the base. In the true cotton the whole seed is covered with hairs.

Thus then, although the result is the same, the mode of arriving at it is very different. He then proceeded to the cases in which the dispersion of seeds is effected by the agency of animals. In many cases the seed is surrounded by a sweet fleshy pulp which is eaten, while the true seeds being surrounded by a tough shell, remain undigested. Such fruits are generally brightly coloured such as the strawberry, peach, apple, currant, &c., the colours like those of the flowers serving to attract animals. In other cases the action of animals is involuntary. These may be divided into two classes: those in which the seeds adhere to animals by hooks, and those in which this is effected by sticky glands. Various cases of both were cited, and specimens shown, especially the South African *Harpagophyton*, a plant whose seeds are provided with terrible hooks more than an inch long. These seeds are said sometimes even to destroy lions, they roll about on the sandy plain, and if one attaches itself to the skin, the wretched animal tries to tear it off, and getting it into its mouth, perishes miserably. Sticky seeds are also thus transported.

SECTION E

GEOGRAPHY

Opening Address by Clements R. Markham, C.B., F.R.S., F.L.S., Sec. R.G.S., F.S.A., President of the Section.

I propose to open the proceedings of this Section by attempting to place in a clear light the objects and aims of geographers, and the position which their science holds relatively with reference to the other sciences, and positively as a distinct body of knowledge with defined limits.

Geography is a knowledge of the earth as it is, and of the changes which have taken place on its surface during historical times. These changes explain to us the laws according to which similar changes are now taking place around us. The subject may be considered from various points of view; but my present endeavour will be to introduce to you, through the remarks I propose to make, the papers that will come before you to-day and at our subsequent meetings. I shall try to do this by explaining the practical uses of geographical knowledge, and its importance to us in almost every occupation in which we may be engaged.

Our first work as geographers is to measure all parts of earth and sea, to ascertain the relative positions of all places upon the

surface of the globe, and to delineate the varied features of that surface. This great work has been proceeding from the first dawn of civilisation, and it will probably be centuries longer before it is completed. Geographers and explorers, surveyors and geodesists, of each generation, work their allotted time, gradually increasing the stock of human knowledge, by enabling other sciences and other branches of inquiry to make parallel advances. For they are all dependent on the accurate measurement and mapping of the earth. Locality is the one basis upon which all human knowledge must rest. Arts, sciences, administration, commerce, depend upon accurate geographical knowledge; and as that knowledge becomes more extensive and more exact, so will every other human pursuit gain increasing light and truthfulness.

We are still very far indeed from an accurate scientific geographical knowledge of even the most civilised countries, while by far the largest portion of the earth's surface is inadequately surveyed, and a smaller, though far from inconsiderable, part is unsurveyed or entirely unknown. In the division of labour, the geodesist produces the accurate large-scale maps which are necessary in thickly populated countries, the topographical surveyor furnishes less exact maps of more thinly peopled and less civilised regions, while the trained explorer forces his way into the unknown parts of the earth.

From the labours of these three classes of workers we, in this generation, and our descendants for many generations to come, must be content to derive our knowledge; but in the fulness of time the whole earth will be measured and delineated as Hallamshire is now. It is to the furthering of this great work that the geographers of each age devote their energies, and its advancement will increase in rapidity, because, as men become better instructed, there will be more geographers.

The construction of large-scale maps on rigorously accurate principles has as yet made inconsiderable progress. It is only in the countries of Europe, and India, and some of our colonies, and in the United States, that it has been commenced. But it is very far from being completed anywhere, and the people of Sheffield have had this fact brought home to them within the last year; for the Memoir on the Yorkshire Coal Field, published by the Geological Survey in 1878, was obliged to stop short with the limits of the county, an artificial and inconvenient line which leaves the southern portion of the field undescribed, entirely because the six-inch survey had not yet been extended over Nottinghamshire and Derbyshire. This circumstance strikes us in two ways. It reminds us that geographical work is far from being completed even in the most populous and civilised parts of our own country; and it also brings the fact home to us that the progress of other sciences is dependent upon the advance of geography.

Where the trigonometrical surveys have not been commenced, we have only those maps which are based on positions fixed by astronomical observations, on cross-bearings and chained distances, and which I call (to distinguish them from the results of trigonometrical surveys) the topographical maps. One of the oldest and most interesting of these maps is the famous atlas of the Chinese Empire constructed by the Jesuits between 1708 and 1718. But we are also dependent on such maps for our geographical knowledge of all Asia except India and Palestine, of the Eastern Archipelago, of all Africa and South America, and of the greater part of North America.

Accurate maps are the basis of all inquiry conducted on scientific principles. Without them a geological survey is impossible; nor can botany, zoology, or ethnology be viewed in their broader aspects, unless considerations of locality, altitude, and latitude are kept in view. Not only as the basis of scientific inquiry, but also for the comprehension of history, for operations of war, for administrative purposes, and for the illustration of statistics, the uses of accurate maps are almost infinite. M. Quetelet, in one of his well-known letters, declared that such graphic illustration often afforded immediate conviction of a point which the most subtle mind would find it difficult to perceive without such aid. Maps both generalise and allow of abstraction. They enable inquirers at once to detect and often to rectify errors, which, if undetected, would affect results and throw calculations into confusion. As an example of the use of maps for administrative purposes, the series constructed by Mr. Edward A. Prinsep, in India, is worthy of notice. They showed the agricultural tribes of a special district arranged according to occupancy of land, political and fiscal divisions, physical features and zones of fertility, productive power as influenced by rain or aided by irrigation, different kinds of soils, acres under different kinds of produce, and lines of traffic. Another most instructive series displays the State irrigation canals acting on improvable waste lands, the depth of wells, the rainfall and zones of drought, and the parts of the country already irrigated. As another noteworthy instance of the use of maps for statistical illustration, I may mention the interesting "Carte agricole de la France," by M. Delesse, which not only shows the extent of arable, meadow, and vine lands, and of woods, but the relative value of lands by shades and contour lines of equal revenue. The idea has been adopted by Mr. Ralph Richardson in his map of Mid-Lothian showing the annual rentals by colours; and of course the colours also indicate the positions of barren mountains, of fertile valleys, and of centres of population. Such maps ought to be far more extensively used than is now the case, for in no other way can economic and industrial facts be so lucidly and clearly, as well as so rapidly, impressed on an inquirer's mind.

The third division in which geographical delineation is classed is that comprised in the labour of pioneer-exploring and discovery. This branch of our subject excites the most interest, because the heroic devotion and gallantry of our travellers is a source of just pride to the nation; and because their perils and hardships, their adventures and discoveries surround them with a halo of romance. Yet these romantic associations are not confined to the pioneers of geography. Though less known, they equally belong to the more scientific geodesist. In the whole range of exploring narrative there is nothing more calculated to excite admiration, nothing more touching, than the devotion of Colonel Lambton, the first superintendent of the Great Trigonometrical Survey of India, the old man who was absorbed in his great work for half a life-time, who wasted away from exposure and hardship, but who, to the last, brightened up to renewed animation and vigour when the great theodolite was before him, and who died at his post in a wild part of Central India. This was sixty years ago, but quite recently the equally heroic death of Captain Basevi was recorded. At 17,000 feet above the sea, in a temperature below zero, and protected only by a light tent, this martyr to science was engaged in the delicate operation of swinging the seconds pendulum. One morning, when gallantly striving to rise from a bed of suffering and to recommence work, he died. Nor do these names stand alone. Assuredly, the more scientific surveyors run equal risks, and deserve equal recognition with their exploring brethren. Still the interest justly attaching to new discoveries naturally commands most popular applause, and the importance of opening up an unknown country cannot well be exaggerated.

In this glorious field there are still harvests to be reaped through the bravery and endurance of future travellers. In spite of all that has recently been done in Africa, there is a vast unknown tract to be discovered. In Asia, in New Guinea, in Sumatra and Borneo, in South America, wide regions also remain unexplored. Above all, the greatest problem of this age awaits solution in the far north, and will call forth the best scientific ability, and all the highest qualities of our naval explorers.

Every year new regions are brought within our knowledge, and we are able to welcome the adventurers home, and to add them to the list of geographical worthies. But, with regard to many explorers, there can be no doubt that much more valuable information might be obtained than is now the case. Men, with various avocations, traverse unexplored or little known countries, who, from want of previous training are unable to lay down their routes or to observe with scientific accuracy and intelligence. There are naval and military officers, missionaries, consular agents, colonial officials and planters, engineers, telegraphers, collectors, and sportsmen or persons merely travelling for pleasure, many of whom are led, by business or curiosity, to penetrate into regions of which little is known. It is most important that there should exist, in this country, the ready means of furnishing the necessary training to such explorers; and the subject has recently received serious consideration from the Council of the Royal Geographical Society.

It has been resolved that a course of instruction shall be supplied by the Society to all who are about to visit unknown or little known countries, and who desire such training. As a preliminary measure, the present arrangement is to give such instruction as will enable the pupil to fix positions by astronomical observations, and to lay down his route; but this is only a beginning, and it is to be hoped that, in due time, such a course of instruction will be provided as will enable an intelligent

traveller to observe with scientific accuracy, and to bring home really valuable results in various branches of inquiry. It is very desirable that this resolution of the Geographical Society should be widely known, and I trust that the local members of this section will co-operate so far as to bear in mind that this aid is offered by the Geographical Society, when the intention of any native of Hallamshire to visit a distant region comes to their notice. Incalculable good may be done to the cause of geography by a system which will have the effect of making every traveller a scientific and intelligent observer.

The surveying and mapping of the ocean is only second in importance to that of the land; and this work also divides itself into three sections, namely, the coasts surveyed, the coasts partially surveyed, and the unsurveyed coasts. Hydrography will not be completed until all the coasts in the world are included in the first section, which is now very far indeed from being the case. Yet this is not merely a question of science, of the study of the physical geography of the sea, interesting as this branch of our subject has become. Upon the accuracy and completeness of charts hangs the safety of thousands of lives, and the prosperity of commerce in all parts of the world. When it is remembered how much depends upon the work of marine surveys, it must be a subject of astonishment that so many hundreds of miles of coast line frequented by our shipping remain unsurveyed; and that even, in some cases, when the surveys have been executed and charts published by foreign governments, they are not accessible in an English form. In the interests of humanity and of the well-being of our trade, the efforts of geographers in urging the completion of marine surveys ought to be cordially seconded by Chambers of Commerce, and by all those whose material interests are concerned in the provision of accurate charts of all coasts visited by our shipping.

Hitherto I have invited your attention to the basis of geography, to the measurement of the surface of land and sea, and of their heights and depths; to the mapping of the world, and to the innumerable uses of maps and charts. But this only forms the skeleton of our science, which is endued with flesh and blood, with life and motion, by those who study the causes and nature of the changes that have taken place and are now taking place upon the earth; by comparative and physical geographers, by those who study and classify natural phenomena, and demonstrate their connection with each other and their places in the great scheme of nature.

Geography and geology are, from one point of view, sister sciences. The former treats of the earth as it now is and of changes which have occurred within historical times. The latter deals with the condition of the earth and the changes on its surface which went on during the cycles of ages before the dawn of history. The two sciences are quite distinct, while they aid each other. No geological survey can be undertaken without the previous completion of geographical maps, and the geologist is enabled to comprehend the condition of the earth in remote ages by studying the phenomena of physical geography. On the other hand, the geographer acquires a correct understanding of the present state of the earth's surface by considering the records of those marvellous changes which can be gathered from history and from the narratives of travellers and observers in all ages. Without their services, geography would lose half its interest.

Comparative geography (the study of the changes which have taken place on the earth's surface within historical times) is, therefore, a most important branch of our science; and it enlists the historian and the topographer in our service. It is a branch of geography which has not hitherto received the amount of attention it deserves.

The importance of the study of history and of early narratives for the elucidation of points in physical geography will appear from the consideration of a few instances. Take for example the great and fertile basin of the river Ganges in India. The Sanscrit historian finds reason for the belief that in 3000 B.C. the only habitable part of the alluvial plain of India was the water-parting or ridge between the Sutlej and the Jumna. The rest was a great estuary or arm of the sea. It has only been fit for man's occupation within the historical period, and hundreds of square miles of the delta have become habitable since the days of Lord Clive. The wonderful history of these changes can be traced by the student, who thus enables the geographer to explain the phenomena which he observes. Mr. Blanford, in his charming work on physical geography for the use of Indian schools supposes a native of the country to be standing on the bank of the river that flows by his village, watching the turbid flood swirling past. The *chur* opposite, which the river left dry when its waters fell at the close of the last rainy season, and which, till lately, was covered by a rich green crop of indigo, is now more than half cut away, and buried beneath the water. Masses, many times larger than the house he lives in, from time to time detach themselves, and are swallowed up by the deep muddy stream. If the Hindu ponders over what he sees he will perhaps be led to make inquiries, and old people will probably tell him that half a century ago the river itself was a moderate-sized *khall*, and that the old channel, seven or eight miles off, now little more than a string of pools, was at that time a great river. These facts and their causes will open to him an interesting chapter in physical geography; which is made more complete and more interesting by the ancient records of his people. But geography is an applied science. This body of facts and their causes is not a subject for mere speculative study only. It is of practical utility; for the knowledge of the way in which Nature has worked in past ages discloses her present and future operations, and enables the enlightened administrator and engineer to work in harmony with them.

Again, to pass to another part of the world. The student of history reads of the great sea fight which King Edward III. fought with the French off Sluys; how, in those days, the merchant vessels came up to the walls of that flourishing seaport by every tide; and how a century later a Portuguese fleet conveyed Isabella from Lisbon, and an English fleet brought Margaret of York from the Thames, to marry successive Dukes of Burgundy at the port of Sluys. In our time if a modern traveller drives twelve miles out of Bruges across the Dutch frontier he will find a small agricultural town surrounded by corn fields and meadows, and clumps of trees, whence the sea is not in sight from the top of the town-hall steeple. This is Sluys. A physical geographer will seek out the causes which have brought about this surprising change. They are most interesting, and most conducive to an intelligent comprehension of his science, and he will find them recorded in history. Thus the historian and the geographer work hand in hand, each aiding and furthering the researches of the other.

Once more. We turn to the great Baie du Mont Saint Michel, between Normandy and Brittany. In Roman authors we read of the vast forest called "Setiacum nemus," in the centre of which an isolated rock arose, surmounted by a temple of Jupiter, once a college of Druidesses. Now the same rock, with its glorious pile dedicated to St. Michael, is surrounded by the sea at high tides. The story of this transformation is even more striking than that of Sluys; and its adequate narration justly earned for M. Manet the gold medal of the French Geographical Society in 1828.

Once again let us turn for a moment to the Mediterranean shores of Spain, and the mountains of Murcia. Those rocky heights, whose peaks stand out against the deep blue sky, hardly support a blade of vegetation. The algarobas and olives at their bases are artifically supplied with soil. It is scarcely credible that these are the same mountains which, according to the forest book of King Alfonso el Sabio, were once clothed to their summits with pines and other forest trees; while soft clouds and mist hung over a rounded shaggy outline of wood, where now the naked rocks make a hard line against the burnished sky. But Arab and Spanish chroniclers alike record the facts, and geographical science explains the cause.

There is scarcely a district in the whole range of the civilised world where some equally interesting geographical story has not been recorded, and where the same valuable lessons may not be taught. This is comparative geography.

The peasant of Bengal sees the mould falling into his turbid river, and learns the first lesson of a course which teaches him the history of the formation of the mighty basin of the Ganges. So should we, in England, to use the words of Professor Huxley, "seek the meanings of the phenomena offered by the brook which runs through our village, or of the gravel pit whence our roads are mended." Their meaning is equally significant, equally instructive, and it is thus that we should all begin to learn geography.

M. de Brazza read a paper *On his Exploration of the Ogové River*, details of which have already been published at various times in NATURE. After leaving the basin of the Ogové and crossing the watershed he came upon the Alima, a large river flowing eastwards, which he has no doubt is a tributary of the Congo.

Captain Gerald Martin had sent home, from the seat of war, a paper *On the Afghan War—the Kurum Valley.*—Captain Martin wrote from the Peiwar Kotal, and he reported on the survey operations conducted by officers of the Indian Survey Department attached to the "Kuram Column" of the Afghanistan expeditionary force. The area comprised the whole of the Kuram Valley and the district of Khost to the south, representing an addition to our geographical knowledge of 4,500 square miles. The paper concluded with a very interesting account of the botany of the Kuram Valley and of its forest-clad slopes (which was furnished by Dr. Aitchison), and with a detailed account of the Hill tribes. The inhabitants of the Kuram Valley are agriculturists and their irrigation works gave evidence of immense labour. A paper by Captain R. Beavan was read describing the country between Kandahar and Girishk.

Lieutenant St. George C. Gore described the *Pishin Valley*, which is now to be annexed by the British Government. Its extreme length is about 48 miles, and its average width including the hill ranges on either side, from 25 to 30 miles. It is a perfectly open, nearly flat, alluvial plain, with a very barren aspect owing to the absence of trees, except fruit trees in a few gardens.

SECTION F—Economic Science and Statistics

Prof. Leone Levi delivered an address upon *The Scientific Societies in Relation to the Advancement of Science in the United Kingdom.*—The importance of the subject, and the renewed effort to rear a building in the Metropolis for several scientific societies, now insufficiently accommodated, had induced him to submit the paper. In the seventeenth century there were only two scientific societies in this country; but at the present time, in an age often described as wholly given to the ignoble occupation of money-making, the calendar exhibited an amount of activity quite unknown at former periods. The membership of the three Royal Societies was then mentioned, and Prof. Levi gave many interesting particulars of societies instituted for the promotion of the physical and mathematical sciences, natural history and biology, archæology and geography, the applied sciences, and instanced a large number of miscellaneous societies. Altogether, including local scientific societies, the number of members of scientific societies in the United Kingdom is about 60,000, or deducting ten per cent. representing those belonging to several societies, about 54,000 individual members. But even that could be scarcely considered as representing men of science, and probably about 25,000 persons was the number of people who had any recognised status in the world of science, or who were actually engaged in the pursuit of science within the British isles. Some facts were then given as to the income of scientific societies.

Eliminating from the total vote the amount expended for elementary education, the proportion devoted to science and art has been considerably diminished. In 1835, the Government of the day voted 65,000*l*. for elementary education, and 70,000*l*. for science and art, or a proportion of 52 per cent. for science and art. In 1878, the vote for elementary education amounted to 3,624,000*l*., and that for science and art to 529,000*l*., or a proportion of 12 per cent. for science and art. Further, Government aid was principally given to physical and natural science, leaving a wide range of scientific exploration altogether unassisted. Great had been the achievements of science in modern times, and England owed to its cultivators a profound debt of gratitude. Our manufactures and industry, our productive power and means of locomotion, all depended for their development on the advance of science, and these scientific societies had a high economic value. Much more, however, remained to be accomplished, and England's hope to maintain her high position in productive industry must depend on the success which men of science might attain in fathoming the inexhaustible secrets of nature, on the increase in the number of patient yet ardent votaries of science, and still more on the diffusion of education and scientific knowledge among the great body of the people.

SCIENTIFIC SERIALS

Bulletin of the United States Geological and Geographical Survey of the Territories (vol. v. No. 1. Washington, February 28).—Notes on the Aphididæ of the United States, with descriptions of species occurring west of the Mississippi, by Chas. V. Riley and J. Monell.—The relations of the horizons of extinct vertebrata of Europe and North America, by E. D. Cope.—Observations on the faunæ of the miocene tertiaries of Oregon, by E. D. Cope.—Notes on the birds of Fort Sisseton, Dakota territory, by Chas. E. McChesney.—Palæontological papers, No. 9.—Fossils of the Jura-trias of South-eastern Idaho, by C. A. White, M.D.—Jura-trias Section of South-eastern Idaho and Western Wyoming, by A. C. Peale, M.D.—Fossil forests of the volcanic tertiary formations of the Yellowstone National Park, by W. H. Holmes.—Palæontological Papers, No. 10.—Conditions of preservation of invertebrate fossils, by C. A. White, M.D.—Supplement to the bibliography of North American invertebrate palæontology, by C. A. White, M.D., and H. Alleyne Nicholson. This supplement embraces publications which have been made during the year 1878, and also all the omissions pertaining to the first list issued as No. 10 of the Miscellaneous Publications of the U.S. Geological Survey. The year 1878 was not productive of many memoirs on North American invertebrate palæontology. Dr. White records the publications made in the United States, Prof. Nicholson those made in British North America, West Indies, and Europe.

The *Verhandlungen der k. k. geologischen Reichsanstalt, Wien* (No. 10, 1879) contain the following papers:—On a new occurrence of celestine in the Banat Mountains, by Fr. von Hauer.—On the distribution of Silurian deposits in the Eastern Alps, by G. Stache.—On a peculiar variety of the greenstone of Dobschau, by S. Roth. The peculiarity of this rock consists in its copious tenor of calcspar, beside felspar and hornblende. Apart from these principal constituents, augite, diallage, and secondary quartz are represented in the mixture. Here and there the hornblende incloses small crystals of pyrites and of nickeline.—On *Cyclocladia major*, Lindl. and Hutt., by Karl Feistmantel.—On a collection of petrifactions from the Silurian deposits made by Herr M. Dusl at Beraun, by Prof. G. Laube.—On the recent eruption of Mount Etna, by Ad. Pereira. The author gives a somewhat scanty description of an ascent he made during the last eruption, during which he actually reached the active crater.—The last paper in the number is a valuable account of an excursion into the district between the Bosna and Drina Rivers (Bosnia), by Dr. E. Tietze.

The *Rendiconto delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna* (1878-79).—From this part we note the following papers:—Observations on some habits of *Vespertilio murinus*, L., and on some studies in comparative anatomy connected with this animal, by Sig. Ercolani.—Notes on an ancient Phœnician skull found in Sardinia, compared to similar skulls of the present time, by Sig. Calori.—On the decomposition of salts of a volatile base and its importance in toxicological operations, by Sig. Selmi.—Note on certain fermentations at low temperatures, by the same.—Researches on the principal phases of the annular eclipse of the sun of July 19 last, partially visible at Bologna, by Prof. Saporeti.—On the ossification of the humor vitreus of the human eye, and on some other strange modifications of the same, by Sig. Ciaccio.—On the equilibrium of plane polygons of variable form, by Sig. Ruffini.—On a new hydrotacchimeter, by Sig. Cesare Razzaboni.—On some researches in analytical geometry, by Sig. Beltrami.—On the thermical and galvanometrical laws governing the formation of the electric spark in gases, by Sig. Villari.—Contributions to the fossil conchology of Italy, by Sig. Foresti.—On the excreting apparatus of *Janus cristatus* by Sig. Trinchese.—On the ossiferous breccia of the S. Teresa cave, by Sig. Capellini.—On the flora of the province of Bologna (third paper), by Sig. Cocconi.—On the history of geodesy in Italy, by Sig. Riccardi.—On a Holtz's machine of special construction, by Sig. Righi.—Chemical researches on the metamorphoses of the marbles of Carrara and of Monte Pisano, by Prof. Santagata.—On the deposits and genesis of phosphates generally and their use in agriculture, by Sig. Predieri.—On the motion of water in vessels communicating by long tubes, by Sig. Cesare Razzaboni.—On the quantitative analysis of mixtures containing alcaline sulphides, carbonates, sulphates, and hyposulphates, by Sig. Cavazzi.—On the origin of the optical nerve in the brain of fishes, by Sig. Bellonci.—On the structure of so-called cellular and parenchymatose cartilage, by Sig. Ciaccio.—On some products of arsenical putrefaction, by Sig. Selmi.—On the thermical and galvanometric laws of the induction spark, by Sig. Villari.

The *Journal of the Russian Physico-Chemical Society* of St. Petersburg (tome xi. No. 6) contains the following papers of